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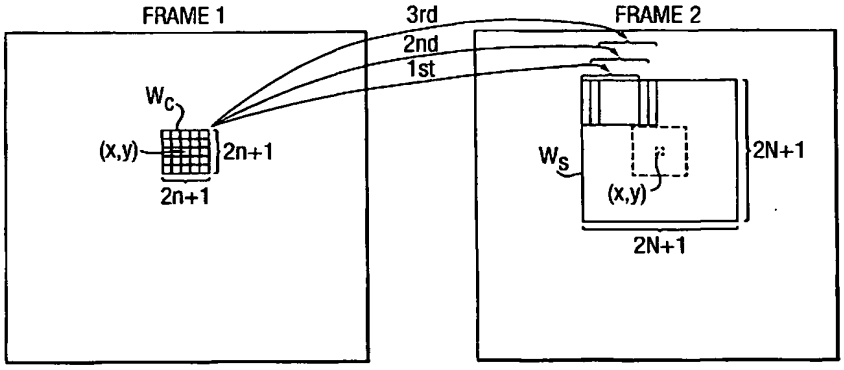
[Continued on next page]

(54) Title: IMPROVEMENTS IN IMAGE VELOCITY ESTIMATION



(57) Abstract: A method of image velocity estimation in image processing which uses a block matching technique in which a similarity measure is used to calculate the similarity between blocks in successive images. The similarity measure is used to calculate a probability density function of candidate velocities. The calculation is on the basis of an exponential function of the similarity in which the similarity is multiplied by a parameter whose value is independent of position in the frame. The candidate velocities are thresholded to exclude those having a low probability. The value of the parameter and threshold are optimised together by coregistering all frames to the first frame, calculating the registration error, and varying them to minimise the registration error. The similarity measure is normalised with respect to the size of the block, for example by dividing it by the number of image samples in the blocks being compared. The similarity measure used may be the $CD_{2\text{-}bis}$ similarity measure in which the mean and standard deviation of the two blocks being compared are adjusted to be the same before calculation of the similarity. This makes the similarity measure particularly suitable for ultrasound images. Further, block matching may be conducted across three frames of the sequence by comparing the intensities in blocks in the first and third, and second and third of the frames and finding the block in the third frame which best matches the block in the second frame and that block's corresponding position in the first frame.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

Inte[illegible]onal Application No
PC[illegible]GB 03/05047

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06T7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AJIT SINGH ET AL: "IMAGE-FLOW COMPUTATION: AN ESTIMATION-THEORETIC FRAMEWORK AND A UNIFIED PERSPECTIVE" CVGIP IMAGE UNDERSTANDING, ACADEMIC PRESS, DULUTH, MA, US, vol. 56, no. 2, 1 September 1992 (1992-09-01), pages 152-177, XP000342529 ISSN: 1049-9660 cited in the application page 154, left-hand column, line 13 - line 48 ----- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 September 2004	04 02 2005

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Int ›nal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	COHEN B ET AL: "New maximum likelihood motion estimation schemes for noisy ultrasound images" PATTERN RECOGNITION, PERGAMON PRESS INC. ELMSFORD, N.Y, US, vol. 35, no. 2, February 2002 (2002-02), pages 455-463, XP004323385 ISSN: 0031-3203 cited in the application page 458, left-hand column, line 8 - line 18	1
A	US 4 667 233 A (FURUKAWA AKIHIRO) 19 May 1987 (1987-05-19) column 3, line 14 - line 62; figures 1,3	1
A	WO 95/26539 A (REBERG JAN OTTO ; AAGAARD MARTENS HARALD (DE); IDT DEUTSCHLAND GMBH (D) 5 October 1995 (1995-10-05) abstract page 12, line 25 - page 13, line 10	1

INTERNATIONAL SEARCH REPORT

itional application No.
PCT/GB 03/05047

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-17,25-30

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17,25-30

A method of processing a sequence of image frames to estimate image velocity through the sequence comprising block matching using a similarity measure, calculating from the similarity meaure a probability measure that the two compared blocks are the same, and estimating the image velocity based on the probability measure, wherein the probability measure is calculated using a parametric function of the similarity which is independent of position in the image frames, corresponding apparatus claim and computer storage medium claim

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2. claims: 18-20

A method of processing a sequence of image frames to estimate velocity through the sequence comprising block matching using a similarity measure by comparing the intensities in image blocks in three frames of the sequence by comparing the intensities in blocks in the first and third and the second and third of the three frames, and calculating the similarity between the said blocks on the basis of their intensities.

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3. claims: 21-24

A method of processing a sequence of image frames to estimate image velocity through the sequence comprising: block matching using a similarity measure by comparing the intensities in image blocks in two frames of the sequence and calculating the similarity between the said blocks on the basis of their intensities, further comprising normalizing the intensities in the two blocks to have the same mean and standard deviation before calculating said similartity.

INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/GB 03/05047

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